CHAPTER 4 | RESTORATION ALTERNATIVES

As noted in Chapter 3, releases of hazardous substances (cadmium, lead, and zinc) have occurred in Cherokee County. FWS believes that these releases have injured the county's natural resources, including surface water resources, ground water resources, plants, and animals. In their uninjured state, these natural resources provided a variety of "services," both to the environment and to people. Services provided to the environment are called "ecological services." For example, clean surface water can provide habitat services–*i.e.*, a place to live–for certain aquatic threatened and endangered species as well as to other aquatic organisms. Surface water also provides foraging opportunities, another kind of ecological service, for animals that eat fish and shellfish. Similarly, clean soils help support healthy vegetation, and the different plant communities that grow in turn provide animals with foraging opportunities, nesting or den areas, and protective cover, all of which are essential ecological services for different species.

In addition to providing ecological services, healthy natural resources can provide services to people. For instance, healthy surface waters can provide opportunities for fishing and boating. Clean ground water can be a source of drinking water. Hunting opportunities may exist where environmental conditions can support sufficiently large populations of favored species.

Releases of cadmium, lead, and zinc due to mining activities in Cherokee County have injured some of its natural resources, and have reduced the quantity and/or value of the ecological and human-use services that these resources would otherwise have been able to provide. Some portion of these injuries was caused by Eagle-Picher's and LTV's mining activities (although other companies were involved as well), and FWS is required to use NRD funds recovered as a result of these activities, as well as any natural resource damages recovered from other responsible parties in the future to restore, rehabilitate, replace, and/or acquire the equivalent of these natural resources and their associated services.

To that end, FWS has identified a number of potential restoration alternatives (Exhibit 18). The restoration alternatives discussed in this RP/EA were selected to generally compensate for the kinds of ecological and human-use services that FWS believes were impacted by local mining operations. For instance, because FWS believes that mine piles have reduced the availability of suitable terrestrial habitat for plants and animals, a variety of restoration alternatives are focused on either preserving high-quality existing habitat or enhancing the quality of poorer habitat.

Most alternatives are divided into those applicable for terrestrial areas and aquatic areas (*i.e.*, rivers and streams, and Empire Lake). An additional "miscellaneous" category of alternatives includes two options not easily categorizable into either of the above two groups.

This restoration plan does not identify specific areas to which restoration alternatives might be applied because the final selection of locations depends on information not available at this time, including information on the current ecological status of many parcels of land as well as information on individual landowner preferences. To best match restoration projects to associated injuries, the restoration alternatives described in this plan are generally intended to be applicable to areas of Cherokee County impacted by the companies from which restoration funds were obtained. However, FWS recognizes that adequate opportunities for restoration activities may not be fully available within these areas. Thus, FWS may pursue restoration projects in other areas. These areas may include "orphan" areas within Cherokee County (*i.e.,* areas for which the responsible party(ies) have not been determined, or are no longer in existence). In certain circumstances, FWS and the State may even choose to implement restoration activities outside of Cherokee County (*i.e.*, neighboring Crawford, Neosho, and Labette Counties, see Alternatives T2 and T3).

Some alternatives are not independent—*i.e.*, they would only be conducted in conjunction with other alternatives. For example, aquatic restocking would only occur if sediments in the area to be restocked had been restored to reduce contamination levels, because without restoration, the restocked fish and shellfish would not survive. Exhibit 18 indicates which alternatives are contingent upon the co-implementation of others.

As noted above, restoration alternatives discussed in this RP/EA are explicitly not intended to replace or duplicate efforts undertaken by EPA or other organizations. Rather, some restoration alternatives could be undertaken to address areas of contamination for which no current EPA or other remediation plans exist; some alternatives address interim losses to natural resources, and some supplement efforts already being undertaken by EPA or other organizations to more rapidly restore injured natural resources to their baseline condition (*i.e.*, see Alternatives T9 and T10).

For both the terrestrial and aquatic restoration alternatives, the discussion begins with the "no action" alternative. Then, the preservation-based alternatives are presented, followed by a variety of other restoration project types, some for former mine waste areas, and others for areas where mine wastes yet remain. The order in which alternatives are presented is not intended to reflect FWS preferences.

EXHIBIT 18 RESTORATION ALTERNATIVES CONSIDERED

NAME	DESCRIPTION	INITIAL HABITAT TYPE	ENDPOINT	REQUIRED CO-ALTERNATIVE(S)
TERRESTRIAL HABITATS				
T1	No action	All	No change	None
T2	Preserve native prairies	Unprotected native prairies	Protected native prairies	None
T3	High quality prairie restoration	Former mine waste area, CRP grasslands, agricultural land, cool season pasture	High quality prairie	None
T4	CRP grassland restoration	Former mine waste area, agricultural land or cool season pasture	CRP grassland	None
T5	Cool season grassland restoration	Former mine waste area, agricultural land	Cool season grassland	None
T6	Remove and dispose of terrestrial mine wastes in subsidences; cap subsidence*	Terrestrial mine waste area	Depends on subsequent restoration action	T3, T4, or T5
T7	Mine waste recontouring*	Terrestrial mine waste area	Depends on subsequent restoration action	T3, T4, or T5
T8	Mine waste recontouring and encapsulation*	Terrestrial mine waste area	Depends on subsequent restoration action	T3, T4, or T5
T9	Apply biosolid amendments beneath planned EPA caps**	Encapsulated mine waste area, revegetated by EPA with native seed mix	More thickly encapsulated mine waste area, revegetated by EPA with native seed mix	None
T10	Improve EPA mine waste caps (through soil amendments and fencing)	Encapsulated mine waste area, revegetated by EPA with native seed mix	Encapsulated mine waste area, with improved native vegetative community	None
AQUATIC HABITATS				
A1	No action	Waterways and Empire Lake	No change	None
A2	Preserve high quality riparian corridor	High quality wooded or grassland riparian corridor	Protected high quality wooded or grassland riparian corridor	None
A3	Preserve Empire Lake buffer	Higher quality Empire Lake buffer	Protected lake buffer	None
A4	Improve riparian buffer	Waterways with poor quality buffers	Buffer of appropriate type and width	None
A5	Dredge waterway(s)	Waterways	Less contaminated waterway	A2
A6	Dredge Empire Lake; install underwater sediment retention structures on Short Creek	Empire Lake	Less contaminated, deeper lake	None
A7	Drain and cap Empire Lake; channelize Spring River	Empire Lake	Terrestrial; habitat type depends on subsequent restoration action	None
A8	Cap Empire Lake sediments in place	Empire Lake	Shallower lake with less-contaminated surficial bottom sediments	None
A9	Aquatic biota stocking	Waterways and Empire Lake	Healthier aquatic community	A5

NAME	DESCRIPTION	INITIAL HABITAT TYPE	ENDPOINT	REQUIRED CO-ALTERNATIVE(S)
MISCELLANEOUS PROJECTS				
M1	Pilot project development	Varies	Varies	None
M2	Public outreach and communication	N/A	N/A	None

* = This alternative applies to areas where EPA has no future remediation/encapsulation plans.

** = This alternative applies to areas where EPA plans to encapsulate mine wastes and is intended to be implemented in conjunction with EPA's remedial activities, including replanting of the encapsulated areas.

4.1 TERRESTRIAL RESTORATION ALTERNATIVES

NO ACTION: ALTERNATIVE T1

Under this alternative, FWS would rely on natural recovery and would take no direct action to restore injured natural resources or compensate for interim lost natural resource services. This alternative would include the continuance of extant, ongoing monitoring programs such as those operated by the Kansas Department of Health and Environment (KDHE) but would not include additional activities aimed at either reducing contamination, reducing potential exposure to contaminants, or enhancing ecosystem biota or processes. Under this alternative, interim losses suffered would not be compensated.

PRESERVE NATIVE PRAIRIES: ALTERNATIVE T2

This alternative aims to preserve those remnants of native prairie that exist (*i.e.*, Exhibit 19), usually as hay meadows, preferably in Cherokee County but also potentially in the neighboring Crawford, Neosho, and Labette Counties. For this alternative, the first task would be to identify those areas of native prairie that remain and to evaluate the ecological health of each. The Kansas Biological Survey (KBS)[37] maintains a Heritage Trust Database that includes records of many candidate properties; additional survey efforts might identify additional parcels for consideration.

EXHIBIT 19 NATIVE PRAIRIE, DIAMOND GROVE, MISSOURI

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

[37] KBS is a non-regulatory public service unit of the state of Kansas and a non-degree granting progressive environmental research unit for the University of Kansas. KBS states that its basic mission is to "gather information on the kinds, distribution, and abundance of plants and animals across the State of Kansas, and to compile, analyze, interpret, and distribute this information." See http://www.kbs.ku.edu (viewed 7/8/04) for more information.

This alternative is aimed at preserving those prairie remnants that are of the highest quality. Prairie quality can be determined using the floristic quality index (FQI), a measure developed by the KBS to evaluate the quality of vegetative communities in Kansas. Additional considerations relating to the selection of specific parcels are set forth in Chapter 6.

Preservation of native prairie remnants could be accomplished either by direct purchase of the land or through the purchase of easements. At this point, FWS has not selected the organizations that would hold the titles to any purchases or easements; options potentially include agencies within the State of Kansas or non-governmental organizations. Land acquisitions may be conducted by government agencies using settlement monies, or directly by settling with PRPs.

To ensure ongoing protection, management of the preserved land is also required. Maintenance of prairie sites should include regular burns (Exhibit 20), as fire is an integral part of prairie health (Packard and Mutel 1997). Fire removes dead stem and leaf litter. This prevents the accumulation of mulch and allows soil to warm faster in the spring, thus lengthening the growing season (Packard and Mutel 1997). Appropriate burning enhances vitality of many prairie grass species, producing taller grasses and more forbs (Duebbert *et al.* 1981). Fire also stimulates microbes in the soil. The ash left behind provides small amounts of nutrients, and also controls the invasion of woody shrubs and trees.

EXHIBIT 20 PRAIRIE BURN, KONZA BIOLOGICAL RESEARCH STATION, MANHATTAN, KANSAS

Photo courtesy of USDA Natural Resources Conservation Service.

Although fire is the preferred method of prairie rejuvenation, alternatives exist. These include yearly mowing or haying, which can simulate fire by removing dead plant matter and reducing the encroachment of deciduous forest and exotic plants (Robertson 1996). Occasional grazing (on a less-than-annual basis) is another approach (Duebbert *et al.* 1981). One or more of these alternatives may be used in areas where fire is not practical.

Ideal management would likely include a combination of regular burning with haying. Excessive burning can be destructive, resulting in a high mortality of insects and invertebrates (Robertson 1996). Similarly, the disproportionate use of haying and total absence of fire can result in the invasion of exotic cool season grasses (Robertson 1996).

Fencing of native prairie areas is important to prevent over-grazing by domestic stock, such as cattle. Over-grazing degrades prairie grasses by eliminating many native grass and forb species, encouraging the increase of several weedy native and non-native species (Robertson 1996).

HIGH QUALITY PRAIRIE RESTORATION: ALTERNATIVE T3

This alternative is aimed at improving the quality of existing, lower-quality land such that it becomes more fully like a native, natural prairie. In theory, high quality prairie restoration could begin with any local habitat type, including agricultural land (Exhibits 21 and 22), cool season pasture (Exhibit 23), Conservation Reserve Program[38] (CRP) grasslands (Exhibit 25), unvegetated former mine waste areas, capped mine wastes, and so forth; however, improving existing moderate-quality prairie would be more efficient. Areas to be restored would either be purchased, or an easement for the area would be purchased from the current landowners.

Although the specific treatment needed (and thus, costs) would depend in part on the initial condition of the land, in general restoration to a high quality prairie would require: site preparation, seed selection and storage, planting, and management (Robertson 1996). The mode of site preparation depends on the vegetation present on the site before restoration and the status of the soil. For instance, a selective herbicide may control most weeds that invade the site during preparation and before any native grasses have grown (Larson 1991). In the case of perennial weeds, these may be treated by exposing roots to winter temperatures before a spring planting. Woody vegetation (*i.e.*, cedars) will also have to be controlled as part of site preparation.

[38] The Conservation Reserve Program is a voluntary program through which private landowners receive annual rental payments and cost-sharing subsidies in exchange for establishing long-term, resource-conserving covers on eligible farmland.

EXHIBIT 21 AGRICULTURAL LAND: SOYBEAN AND CORN STUBBLE, CHEROKEE COUNTY

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

EXHIBIT 22 AGRICULTURAL LAND: WINTER WHEAT, CHEROKEE COUNTY

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

EXHIBIT 23 COOL SEASON PASTURE, MANHATTAN, KANSAS

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

To maximize species richness, seed mixes should be of high quality and diversity, with a full complement of species (Robertson 1996). FWS anticipates that the seed mix in this alternative would include at least half a dozen warm grass species, and in excess of 15 forb species. Ideally, seeds should originate within a few hundred miles of the restoration site. Planting in the fall, winter, or early spring ensures that seeds have germination moisture (Whitney 1998).

To ensure ongoing development and protection of the new prairie areas, management of the land is required. Anticipated management tasks include: targeted reseeding; burning, and haying or mowing; fence maintenance; and (possibly) application of herbicide. Targeted reseeding can enhance diversity if certain plants do not grow after an initial seeding attempt. As noted above, burning and/or haying are important to rejuvenate the prairie. Fencing is necessary to prevent livestock from excessively removing native species (thereby providing an opportunity for invasive weeds), as well as to prevent general habitat degradation such as trampling and soil disturbance. Herbicides may also be used to control invasive species; however, they should be used cautiously, as these chemicals can harm native plants. If appropriate, herbicides may be used to reduce the population size of a particularly aggressive species, after which mechanical methods such as mowing or hand-pulling, or natural methods such as burning can further eliminate the problem, as some non-native weeds are not adapted to fire (Larson 1991). Evaluation of the success of this alternative could include reliance on measures such as the Kansas Biological Survey's FQI, species abundance/diversity measurements, percent cover, vegetative biomass measurements, or other metrics.

EXHIBIT 24 UPLAND AREA NEAR SPRING BRANCH, CHEROKEE COUNTY, RESTORED WITH NATIVE SPECIES

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

CRP GRASSLAND RESTORATION: ALTERNATIVE T4

Restoration to CRP grassland (Exhibit 25) could begin with habitat types where current ecological conditions are inferior to those that would be provided by the restored grassland. These habitat types include agricultural land (*i.e.*, Exhibits 21 and 22), cool season pasture (Exhibit 23), and unvegetated or sparsely vegetated former mine waste areas. Areas to be restored would either be purchased, or an easement for the area would be purchased from the willing landowners. The level of interest from landowners is not currently known.

EXHIBIT 25 CRP GRASSLAND, CHEROKEE COUNTY

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

Although the specific treatment needed would depend in part on the initial state of the land, in general a CRP restoration effort would be similar to the prairie restoration process described above. First, seeds used for planting restoration sites should be collected from areas proximal to the site, and as diverse a mix of native species as possible should be used. At a minimum, the seed mix would be similar to that employed by the CRP program in Kansas, which is a mix of five warm season[39] native grass species, including switchgrass (*Panicum virgatum*), Indiangrass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), and sideoats grama (*Bouteloua curtipendula*). Herbicides may be helpful to control proliferation of cool season weeds if used sparingly and in conjunction with mechanical or natural methods (Cunningham 1997).

As for prairie restoration, fencing and long-term maintenance are required. Once planted, native grasses take about three years to establish (Packard and Mutel 1997; Kindscher and Tieszen 1998). After the stand matures, maintenance usually involves occasional mowing or burning, usually at a frequency of three to five years or more (Cunningham 1997). This frequency depends on local climate and field conditions and will not only benefit native plants, but will help control non-native weeds as well. Evaluation of the

[39] Warm season grasses use a carbon dioxide-concentrating mechanism to photosynthesize efficiently in hot, dry climates. This mechanism reduces water loss by minimizing CO_2 diffusion, making these grasses highly water use efficient and able to live in hotter, drought-prone climates.

success of this alternative could include reliance on measures such as the Kansas Biological Survey's FQI, species abundance/diversity measurements, percent cover, vegetative biomass measurements, or other metrics.

FWS notes that the CRP grassland restoration projects described in this RP/EA (and conducted using bankruptcy funds) are not part of the official NRCS CRP program. The CRP term is used here merely to describe the typical type of seed mix proposed for this warm season grassland restoration alternative.

COOL SEASON GRASSLAND RESTORATION: ALTERNATIVE T5

Cool season grassland establishment (with species such as brome or fescue) is most appropriate for habitat types where current ecological conditions are inferior to those that would be provided by the restored grassland (Exhibit 26). These habitat types include agricultural land, and unvegetated or sparsely vegetated former mine waste areas. Areas to be restored would either be purchased, or an easement for the area would be purchased from the current landowners.

Although the specific treatment needed would depend in part on the initial state of the land, in general a cool season grassland restoration effort would require site preparation, seed selection, planting, and management.

As for other ecological replanting efforts described above, fencing and long-term maintenance are required. Cool season grass stands may persist for many years with the right management, including fertilization. Cool season grasses require substantial fertilization with nutrients such as phosphorous, nitrogen, potash, calcium, magnesium, sulfur, and potassium (MDNR 2003, KSU 1998). Soil should be tested on a regular basis (MDNR 2003).

Haying or mowing should be delayed at least three years after initial seeding until the plants have a well-developed root system, or else young seedlings may be uprooted and destroyed (Redmon 1997). Other management techniques for newly established cool-season perennial grasses include the use of herbicides to control unwanted weed competition and the use of insecticides to prevent insect damage to young seedlings (Redmon 1997). Every three to four years, reseeding with legumes, which enrich soil nitrogen, can help maintain forage quality (MDNR 2003).

EXHIBIT 26 COOL SEASON GRASSLAND, CHEROKEE COUNTY

Photo courtesy of John Miesner, U.S. Fish and Wildlife Service.

REMOVE AND DISPOSE OF TERRESTRIAL MINE WASTES:[40] ALTERNATIVE T6

Although the vast majority of mine wastes originally in Cherokee County have been removed, significant amounts remain and have not been fully remediated. Currently remaining mine wastes include orphan piles at Baxter Springs, as well as mine wastes at Treece. Although EPA initially did not address these orphan piles "due to technical impracticability" (EPA 1997), in 2006 EPA retracted the technical impracticability waiver and issued an amendment to the Record of Decision that addresses the remaining mine waste through excavation and/or consolidation followed by encapsulation, or to the maximum extent practicable, disposal in subsidences or other mine workings in the area (EPA 2006). However, at this time, it is unclear as to exact extent of orphan mine waste that will eventually be addressed–for example, EPA's plans rely on responsible chat sales before and during remedy implementation to reduce the volume of mine wastes. As a result, there may be some unquantifiable amount of unaddressed mine wastes that will remain following the EPA remedy. Furthermore, prior EPA remediation of the Galena subsite has not met restoration goals: many areas support little if any vegetation, and the vegetation that survives bears little resemblance to the varied community of native grasses and forbs that is the goal of restoration activities (Exhibits 27 and 28). EPA has

[40] Mine wastes are the property of the landowners on whose property the wastes reside. FWS recognizes the need to obtain landowner approval before the removal of any mine wastes.

no current plans to more completely address the problems that these mine wastes continue to pose, and consequently, these areas are potential targets for this restoration alternative.

As described in the Cherokee County Phase I Damage Assessment Plan (IEc 2004), plants will not thrive on mine wastes, which also increase the loadings of metals into local creeks and rivers and may contribute to ground water contamination.

This alternative includes physically removing remaining chat or bullrock piles, or other mine wastes, and disposing of them. Removed wastes must be disposed of in a manner that minimizes human health and ecological risks. In theory, options for the disposal of wastes include: (a) emplacement in subsidences or other mine workings in the area, (b) emplacement in an offsite repository, and (c) beneficial re-use. Emplacement in an offsite repository is likely to be prohibitively expensive. This alternative therefore contemplates disposal of these wastes on-site in appropriate subsidences. To minimize the potential for metals from the wastes to leach into surface waters, these subsidences must not be located near streams or floodplains.

After filling the subsidence with mine wastes, the subsidence would be capped with 18 inches of clay and topsoil, amended with biosolids at a rate of 100 tons per acre and associated materials (lime and carbon-rich matter),[41] and then revegetated using one of the above-mentioned revegetation alternatives (*i.e.*, high quality prairie replanting or CRP grassland replanting). Cap material would also come from a nearby location to minimize transportation costs and to ensure that the soil type is consistent with that naturally present in the area. The borrow sites (*i.e.*, the sites from which the capping soil is taken) would need to be carefully reconstructed to aid their recovery. Borrow material would only come from previously disturbed areas, not pristine sites. The areas from which mine wastes are removed would be revegetated using one of the above-mentioned revegetation alternatives (*i.e.*, high quality prairie replanting or CRP grassland replanting).

Ongoing monitoring and maintenance tasks would likely include regular checks of the cap's stability, patching if needed, fence maintenance, plus activities associated with maintenance of the cap's vegetation (discussed previously).

MINE WASTE RECONTOURING: ALTERNATIVE T7

Instead of removing and disposing of mine wastes, another option is to recontour the wastes to reduce erosion and runoff. This would entail the use of earthmoving equipment to even out the profiles of some tall piles of wastes and make them more consistent with the surrounding area. EPA selected this alternative for much of the mine wastes at the Galena subsite (OU 5) (EPA 1989). Mine waste recontouring would be conducted in combination with one of the revegetation alternatives described above, and would require long-term monitoring.

[41] For a description of biosolids, see Alternative T9.

MINE WASTE RECONTOURING AND ENCAPSULATION: ALTERNATIVE T8

Similar to the remedial alternative selected by EPA for the Baxter Springs subsite (OU 3) (EPA 1997) and remaining mine wastes in Cherokee County (EPA 2006), this alternative includes recontouring remaining mine wastes, followed by capping with soil from a nearby borrow site. To minimize maintenance costs and maximize the likely longevity of this remedy, this alternative includes a cap at least 18 inches deep, constructed of clay and topsoil.[42] Cap material would come from a nearby location, to minimize transportation costs and to ensure that the soil type is consistent with that naturally present in the area. The borrow sites would need to be carefully reconstructed to aid their recovery.[43]

FWS anticipates that the capped area would also be amended with biosolids at a rate of 100 tons per acre and associated amendments (lime and carbon-rich matter) and revegetated using one of the revegetation alternatives described above (*i.e.,* high quality prairie replanting or CRP grassland replanting).[44] Encapsulated areas must be fenced to prevent cattle from inadvertently disturbing the cap and re-exposing the mine wastes. Ongoing monitoring and maintenance tasks would likely include regular checks of the cap's stability, patching if needed, fence maintenance, plus activities associated with maintenance of the cap's vegetation (discussed previously).

APPLY BIOSOLID AMENDMENTS BENEATH PLANNED EPA CAPS: ALTERNATIVE T9

This alternative includes integrating biosolids application with the anticipated EPA remedy by deep-tilling biosolids, additional organic matter, and lime into consolidated mine wastes prior to placement of EPA's soil cap. Deep tilling these amendments, at a rate of 100 tons per acre, will help to rehabilitate the soil and support a healthy native plant community.

Biosolids refer to the semi-solid residual materials from municipal wastewater treatment plants that use activated sludge treatment processes (also known as sewage sludge) or other composted, nutrient-rich waste products. Biosolids have been shown to stabilize metals, rendering them less biologically available and therefore unable to exhibit toxicity. In addition to biosolids, lime is added to the amendment mixture to keep the soil calcareous. Carbon-rich matter, such as hay, yard wastes, wood chips, or sawdust, is also added to maintain the proper carbon-nitrogen ratio within the treated soil. FWS prefers native prairie hay because it tends to contain native seeds that result in an improved restoration result.

Adding the proposed biosolids amendments to EPA's intended site remedial actions will build a thicker soil profile with a subsoil under the cap that has been stabilized to reduce

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[42] Although EPA's Baxter Springs remedy used a six-inch thick cap in some places and an 18-inch cap in others, the proposed remedy for the Badger/Waco/Crestline subsites includes an 18-inch cap over all areas (EPA 2004a).

[43] It may also be possible to construct a borrow site such that it can be subsequently used as a small wetland, thereby benefiting aquatic and water-associated species.

[44] For a description of biosolids, see Alternative T9.

metal availability and improve restoration of native prairie soil. Consistent with EPA's Record of Decision, EPA will then cover the biosolids application/mine waste mixture with a soil cap one foot to eighteen inches deep and revegetate with a native seed mixture. Encapsulated areas must be fenced to prevent cattle from inadvertently disturbing the cap and re-exposing the mine wastes. Ongoing monitoring and maintenance tasks would likely include regular checks of the cap’s stability, patching if needed, fence maintenance, plus activities associated with maintenance of the cap’s vegetation (discussed previously). These tasks would be undertaken by the State of Kansas, and are not included in the Trustees’ estimated expenditures for this alternative.

IMPROVE EPA MINE WASTE CAPS: ALTERNATIVE T10

At some sites in Cherokee County including Baxter Springs and Treece, EPA has previously undertaken mine waste recontouring and encapsulation remedial actions. Under this Alternative, the Trustees would add seed and soil amendments (but no biosolids) and would fence the area to protect new growth from livestock if necessary. This will generally increase the area's ability to support healthy native plant community for many years. Ongoing monitoring and maintenance tasks would likely include regular checks of the cap’s stability, patching if needed, fence maintenance, plus activities associated with vegetation maintenance. These tasks also would be undertaken by the State of Kansas, and are not included in the Trustees’ estimated expenditures for this alternative.

4.2 AQUATIC RESTORATION ALTERNATIVES

NO ACTION: ALTERNATIVE A1

Under this alternative, FWS would rely on natural recovery and would take no direct action to restore injured natural resources or compensate for lost natural resource services pending environmental recovery. This alternative would include the continuance of extant, ongoing monitoring programs such as those operated by KDHE but would not include additional activities aimed at either reducing contamination, reducing potential exposure to contaminants, or enhancing ecosystem biota or processes.

PRESERVE HIGH QUALITY RIPARIAN CORRIDORS: ALTERNATIVE A2

This alternative aims to preserve those stretches of high quality riparian corridor that remain in Cherokee County. FWS will also consider areas of high quality riparian corridor in Jasper County, Missouri, near the state line. Riparian corridors are an integral part of the ecosystem health of surface water bodies. Healthy riparian corridors contribute to overall water quality and ensure the health of the aquatic ecosystem. Riparian corridors reduce runoff from lead and zinc mining impacted areas as well as stabilize existing near stream areas that have easily erodible soils and degrade stream quality. Furthermore, riparian corridor restoration would be necessary after sediment restoration (Alternative A5) to repair construction-impacted banks. The protection and enhancement of the riparian corridors will promote the recovery of aquatic organisms, in some cases federally and state listed and candidate aquatic species (*i.e.*, Neosho madtom and Neosho mucket) as well as other fish, mussels, and aquatic life from the direct effects of mine waste contamination.

The first task would be to identify those areas that remain and to evaluate the ecological health of these areas. As noted previously, the KBS maintains a database that includes records of many candidate properties; additional survey efforts might identify additional parcels for consideration.

Under this alternative, FWS's approach would be to prioritize for preservation those parcels that are of the highest quality. Ecosystem quality can be determined in part using KBS's floristic quality index. FWS will also consider the width of the corridor: wider corridors are more protective and provide more ecological services, including enhanced connectivity of the site to other high quality areas. FWS prefers 300 foot corridors (on each side of the river) in width for perennial streams, or at least 100 feet in width (on each side) for ephemeral or intermittent creeks and streams, but will accept less protective corridors of 100 feet width for perennial streams, or 50 feet width for ephemeral or intermittent streams. Areas that are less wooded may be improved and restored (see Alternative A4). Areas to be preserved would either be purchased, or an easement for the area would be purchased from willing landowners.

To ensure ongoing protection, management of the preserved land is also required. For grassy corridors, preservation techniques are likely to be similar to those for prairies. However, techniques for wooded corridors would differ: for instance, controlled burning is not generally recommended. Fencing is important to keep out cattle, although to encourage understory development and stimulate younger plants, occasional flash-grazing or timber removal may be appropriate. Because cattle will generally be excluded from these areas, it may be necessary to provide an alternate water source for any livestock. Where this alternative is carried out, alternate water supplies would be evaluated, and the most efficient method would be used to provide water to livestock.

PRESERVE EMPIRE LAKE BUFFER: ALTERNATIVE A3

Similar to A2, this alternative aims to preserve those stretches of higher quality habitat adjacent to Empire Lake. FWS expects that this alternative would only apply to the eastern shores of the lake, which is less developed than the western shores.

The methods used to identify candidate parcels for preservation would be similar to that described for A2 above. To help ensure adequate buffering capacity of the preserved areas, FWS prefers 300 foot corridors (on each side of the river) in width, but will accept less protective corridors of 100 feet width for Empire Lake shores.. Areas to be preserved would either be purchased, or an easement for the area would be purchased from willing landowners. To ensure ongoing protection, management of the preserved land is required. Fencing is important to keep out cattle, although as for wooded riparian buffers, to encourage understory development and stimulate younger plants occasional flash-grazing or timber removal may be appropriate.

IMPROVE RIPARIAN BUFFER: ALTERNATIVE A4

Buffer areas next to waterways provide a variety of valuable ecological services. Not all waterways in the impacted area have adequate buffer areas: some buffers are of low quality, and other areas effectively have no buffer at all. This restoration alternative, therefore, includes: the purchase of land or easements on land, activities needed to create an appropriate buffer ecosystem for the site, and monitoring and maintenance of the site.

The appropriate buffer ecosystem to restore depends in significant part on the size of the waterway. For intermittent streams and small creeks, high quality prairie or grassland may be the most appropriate buffer. For larger creeks or rivers, buffers would more likely be forested.

The restoration approach for prairie or grassland buffers would be similar to that described previously. For forested areas, specific restoration actions would include site preparation (possibly including mowing, herbicide application, and tillage), followed by planting a combination of seeds, seedlings, and older plants. Additional applications of herbicide may be needed at appropriate junctures to allow the trees to better establish themselves relative to weedy species or grasses. Species will be selected to match the growing conditions of the planting site.

To ensure ongoing protection, management of the new buffer areas is also required. For both grassy corridors and woody areas, fencing is important to keep out cattle. Because cattle will generally be excluded from the new buffer areas, it may be necessary at certain locations to provide an alternate water source for any livestock. Additional preservation techniques for grassy buffers are similar to those described above for prairies. As noted above, for wooded corridors, occasional flash-grazing or timber removal may be appropriate. Evaluation of the success of this alternative could include reliance on measures such as the Kansas Biological Survey's FQI, species abundance/diversity measurements, percent cover, vegetative biomass measurements, or other metrics.

DREDGE WATERWAY(S): ALTERNATIVE A5

Several miles of Cherokee County's streams and rivers have been contaminated by mining activities, and in a number of spots, visible bars of mine wastes remain. These bars and other areas of high contamination ("hot spots") contribute to waterborne contamination and pose a risk to the fish and other animals that live in the water. This alternative entails dredging these hotspots.

Under this alternative, areas of high contamination would be identified through the use of X-ray fluorescence (XRF) and potentially other techniques. Once identified, these areas can be dredged using equipment appropriate to stream-specific conditions. Hydrological, geological, and morphological conditions will be taken into account in the specific dredging design process in order to maintain and/or improve the stream's ability to support native flora and fauna. In some cases, this may include replacing the contaminated material with clean fill from another site. The major goal of sediment restoration is to remove the contaminated material in a way that minimizes disturbance of the remaining aquatic communities and their supporting habitat, reduces the quantity of contaminated material in the stream, and minimizes erosion and head-cutting in streams. FWS anticipates adopting one or more of the following four sediment removal techniques:

1) <u>Sediment removal in tributaries</u>: Dredging of wetted sediments (those sediment located under water) may be required for some streams or specific reaches (*i.e.*, "hot spot dredging"), depending on stream size and extent of contamination. To prevent serious damage to stream hydrology and ecology, flow control structures would be installed to protect excavated areas and restore the natural hydrology of the stream following sediment removal. Following sediment removal, clean sediment, or the larger uncontaminated fraction of sediments separated after screening, could be returned to the stream to allow normal stream channel and flow. Contaminated sediments would be dewatered and hauled by truck for disposal (*i.e.*, in repositories or subsidences or other mine workings in the area).

2) <u>Sediment removal from confluences in the Spring River with major tributaries</u>: Confluence areas created where major tributaries enter into the mainstem of a larger river are prime areas for deposition of highly contaminated fine sediments. A 2005 USGS report on the Spring River in Cherokee County found relatively higher levels of contaminants in sediments immediately downstream of confluences with major tributaries such as Center Creek and Turkey Creek (Pope 2005). As a result, they offer an area from which sediments could be removed periodically over time based on redeposition rates. Such areas include the confluences of the Spring River and Center Creek, Turkey Creek, and Short Creek. Depositional area dredging involves either the complete removal of all sediment or the finer contaminated fraction separated from the sediments by screening and the larger uncontaminated fraction returned to the river.

3) <u>Sediment removal behind dams</u>: Sediments and streams will typically transport and accumulate behind impediments to stream flow. These impediments act as sediment traps and include structures such as dams. Dams are not 100 percent effective in trapping sediments; some amount of contaminated sediments is still transported beyond the dams. Even so, since dams act as sediment traps: they offer an area from which sediments could be removed on a periodic and repeating basis. Dams in Kansas include low-head dams that can be installed in tributaries just upstream of their confluences with the Spring River, an existing low-water dam located in the Spring River near Baxter Springs (south of Highway 166), and two existing dams that create Empire Lake (Alternative A6). Dredging behind dams could occur periodically with time between removals based on sediment accumulation rates.

4) <u>Gravel bar mining</u>: Gravel bar mining is the removal of sediment associated with exposed gravel bars (above the water line) during low flow conditions. By removing only the exposed portion of the gravel bar, stream erosion and head-cutting are minimized or eliminated. Gravel bar mining could include either the

complete removal of all exposed sediment or the finer contaminated fraction separated from the sediments by screening and the larger uncontaminated fraction returned to the gravel bar. Gravel bar mining will occur periodically over time between removals based on type of gravel bar mining used and gravel bar redeposition rates.

FWS anticipates that removing the mine wastes described above from Cherokee County's streams and rivers would be a significant effort. Due to its likely scale, FWS believes that the only reasonable alternatives for disposal of the removed materials are subsidences or other mine workings in the area, locally-constructed repositories, and consolidation and encapsulation with existing surface mine wastes.

DREDGE EMPIRE LAKE AND INSTALL UNDERWATER SEDIMENT RETENTION STRUCTURES ON SHORT CREEK: ALTERNATIVE A6

Considerable sediment has accumulated behind the Empire Lake dam resulting in shallow water depths throughout most of the lake. Findings from a 2006 USGS report on Empire Lake indicate that although Empire Lake is no longer net depositional, it contains sediments with metal concentrations well above sediment quality guidelines, impairing its use as habitat for animals (Juracek 2006). One restoration alternative to address this situation is to dredge the lake, which is about 400 acres in size. Ideally, all mine waste materials in the lakes would be removed, and the lake's bottom would be returned to the original contour it possessed when first dammed. The total volume of contaminated sediments in Empire Lake estimated in the USGS report is about 1.6 million cubic yards.

FWS anticipates that EPA will remove all contaminated sediments from Empire Lake; however, EPA has not yet made a formal decision on OU2, which includes the lake. Furthermore, contaminated sediments remaining in the Spring River watershed not addressed by EPA, FWS, or other organizations will continue to migrate downstream to Empire Lake. The USGS report indicated that a large portion of the current sediment bed was deposited following a major flood event in the early 1950s, and that by 2006, Empire Lake had re-established its sediment bed and was no longer capable of trapping sediments in all flow regimes. Based on this report, FWS assumes that the contaminated sediment bed in Empire Lake would return within 50 years following EPA's assumed removal action, and that a second removal action would be required. The second sediment removal action is expected to occur 50 years after completion of the first removal action (*i.e.,* 2074), and will also take five years to complete (*i.e.,* 2079).

Clearly, removal of all these sediments would be a large effort. FWS estimates that dredging operations alone, excluding time for the preparation and detailed design of dredging activities, could take about five years. Due to the anticipated costs and scale of the effort, FWS believes that the only reasonable alternatives for disposal of the removed materials are subsidences or other mine workings in the area, locally-constructed repositories, and consolidation and encapsulation with existing surface mine wastes.

A significant fraction of the sediment load to Empire Lake comes from Short Creek (KDHE 1980). Dredging the lake makes the most sense in combination with additional actions to reduce the load of mine waste materials that enter the lake. This alternative therefore also includes the construction of three underwater sediment retention structures (*i.e.,* underwater dams) (Alternative A5, No. 3). These dams would be designed to allow continuous water flow and would include a V-notch or similar feature to facilitate fish and other aquatic organism movement over the dams. Designed to retain sediments, the sediment collection basin created by these dams would need to be dredged regularly as part of ongoing monitoring and maintenance of the project.

DRAIN AND CAP EMPIRE LAKE: ALTERNATIVE A7

Empire Lake is an artificial lake that was formed when a dam was erected by the Empire District Electric Company in the early 1900s. Draining the lake and capping the contaminated sediments that today comprise the bottom of the lake is one way to reduce the impact of these sediments on aquatic biota. As part of this effort, the Spring River's original flow pathway through the area would need to be redirected temporarily.

FWS does not believe that draining and capping Empire Lake is an acceptable solution. For one, the lake is private property, owned by the Empire District Electric Company, and the company asserts that it needs the lake to operate its coal-fired power plant. For another, Empire Lake is the only lake in the county and has significant recreational value to the county's inhabitants. Furthermore, private property owners with access to the lake would likely see the value of their property reduced. For all these reasons, FWS does not consider this alternative to be acceptable and does not consider it further.

CAP EMPIRE LAKE SEDIMENTS IN PLACE: ALTERNATIVE A8

In theory, one alternative for addressing contamination in a lake is to engineer and install a cap over the contaminated sediments. The cap would be designed to reduce the mobility of the contaminants and render them less accessible to aquatic plants and animals. However, the inputs of sediment and mine waste inputs over many decades have made Empire Lake quite shallow, such that capping the lake is not technically feasible. FWS therefore does not consider this alternative further.

AQUATIC BIOTA STOCKING OF RIVERS, STREAMS, AND/OR EMPIRE LAKE: ALTERNATIVE A9

Available data suggest that the aquatic biota in Cherokee County has been impacted by mining wastes. Many stretches of Cherokee County's rivers and streams lack the species diversity originally present in the region, and some stretches lack even the diversity that is present in upstream reaches less impacted by mining wastes (*i.e.,* Angelo *et al.* 2007, Obermeyer *et al.* 1995). Available data also suggest that Empire Lake's biota may be impacted by mining wastes (Ferrington *et al.* 1989).

An aquatic biota stocking program would help replace some of the lost native species, with a goal of restoring the population to its baseline condition (*i.e.,* the condition that would have existed in the absence of mining-related releases of hazardous substances). Restoring fish and mussel populations is essential to replace the stream ecology functions within the Spring River watershed. Notably, the Neosho mucket mussel is a candidate species for listing pursuant to the Endangered Species Act because of declining populations across its historical range. Only black bass (largemouth, smallmouth, and spotted) serve as the host for Neosho mucket larvae, called glochidia, which the female releases in late spring. Restoring mussels also provides important ecological and economic public benefits. Mussels serve as a food resource for other aquatic and terrestrial predators, filter particulate matter from the water column which improves water quality, provide biogenic structure as habitat, and facilitate the benthic invertebrate community by altering the availability of resources through nutrient excretion and biodeposition (Spooner and Vaughn 2006). Fortunately, attempts to grow the Neosho mucket mussel on hatchery bass and restocking larval mussels into suitable habitat have proven successful (*i.e.*, Great Plains Nature Center (Kansas), Missouri Department of Conservation), supporting the feasibility of this restoration option.

Culture and reintroduction of mussels and fish species would be calculated on a species basis. FWS would review the state and federal Threatened and Endangered (T&E) lists and the list of state species of concern to identify those species to be included in the stocking program.[45] FWS anticipates that the total number of species restocked in this program would be fewer than ten and would include native fish, mussel, and snail species. Restocking would occur on an annual basis but could include different groups of organisms at different frequencies. For instance, mussels might be restocked every five years, snails every two years, and fish every two to five years depending on the species. The program would include monitoring to evaluate the success of the restocking effort. Possible metrics of success would include (for example) average count of mussel larvae and snail transplants per square meter. As noted previously, FWS would consider an aquatic biota stocking program only if an aquatic dredging program were first implemented to reduce current contaminant concentrations in the surface water environment. Given current levels of contamination, FWS believes that an aquatic biota stocking program would be unlikely to succeed within affected reaches of Tar Creek, Spring River and tributaries on the site.

4.3 MISCELLANEOUS ALTERNATIVES

In this last category are two restoration alternatives not easily categorizable into either terrestrial or aquatic habitats. Although these alternatives would not have direct, substantive effects on Cherokee County's natural resources, they are potentially important restoration components that would be part of an overall restoration development and management program.

PILOT PROJECTS: ALTERNATIVE M1

As described in more detail in Chapter 5, a substantial amount of information is available about a number of the restoration alternatives considered in this RP/EA. However, in certain cases pursuing one or more pilot studies would maximize the probability of

[45] This approach is consistent with Kansas' listing process and the recovery of imperiled mussel and fish species across known habitats within the Tri-State watershed.

success and allow FWS to use available funds in the most efficient fashion. Examples of such studies include (but are not necessarily limited to):

- **Revegetation method development.** Although a reasonable amount of information exists about methods for prairie restoration and warm season grassland restoration, Cherokee County is faced with some unusual challenges, including the existence of soils subject to contamination, compaction, and possibly other kinds of degradation. Relatively little information exists on methods for maximizing the success of restoration efforts under these circumstances. Initial studies of new and/or modified approaches to vegetative restoration might greatly aid in the long-term success of any revegetation efforts conducted under this program.

- **Subsidence disposal evaluations.** At the current time, only preliminary information exists about the potential for ground water contamination if mine wastes are disposed of in subsidences. Additional experiments, with more extensive and closer monitoring, would aid in the evaluation of this alternative and its potential for application at different sites within Cherokee County.

- **Biosolids amendment evaluations.** Additional evaluation of integrating biosolids amendments with existing and planned EPA caps is needed to reduce the risk of project failure. The optimal mix and composition of amendments (biosolids, lime, and carbon-rich matter) will have to be developed, which will likely vary with contaminant concentrations, site conditions, and EPA's remedy. In addition, nearby reliable sources of biosolids will have to be found and tested.

PUBLIC OUTREACH: ALTERNATIVE M2

FWS values communication with the public and input from the public. Public participation and interest is a key consideration in the evaluation of restoration alternatives. FWS also recognizes the central role that landowners will play in the ultimate success of any restoration alternative in Cherokee County: indeed, success is absolutely dependent on identifying landowners who are willing to sell land or easements on land, in order to allow restoration to take place. To help identify those individuals and to encourage participation, FWS is interested in developing a variety of educational materials, potentially including:

- Development of an educational film, potentially including oral history recordings. This film would focus on the history of mining in Cherokee County, its impacts, and restoration options; and

- Development of fact sheets, newsletters, or other educational materials (electronic and hard-copy) on relevant topics for distribution to interested parties.

The likely topics to be addressed include the history of mining in the area, information on natural resources injuries, and descriptions of proposed restoration options.

As part of its public outreach efforts, FWS also proposes to fund public meetings. These meetings would both serve as another opportunity for the public to learn about FWS's proposed restoration program and would provide opportunities for the public to provide input and ask questions about the program.